

STATISTICAL REASONING'S NEW LOOK

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“Statistical Reasoning in Public Health” is an introductory, two-quarter biostatistics class taught both online and in person to graduate students at the Johns Hopkins Bloomberg School of Public Health. The emphasis of the S sequence is on developing the statistical literacy of enrolled students. The course has been taught for 16 years, and for the past 10 years has had the same instructor for the online and on-campus section. After several partial makeovers, and a questionable choice of incorporating Stata code into the course materials, a complete makeover was undertaken in 2013. This makeover was not only designed to unify the course materials, update the data and literature examples, and to provide more feedback opportunities for students, but also to ready the course for its Coursera debut in January 2014.

BACKGROUND

Statistical Reasoning in Public Health (I and II) is a two-quarter (term) course taught at the Johns Hopkins Bloomberg School. First offered in 1997, the course was designed as one of three introductory series in biostatistics offered concurrently. The emphasis of the Statistical Reasoning sequence is on the appropriate use and interpretation of statistical methods as applied to public health and medical study data, and on developing the statistical literacy of enrolled students. The goal of the course is to make students "statistically literate" so that they can critically analyze the research literature in their field of interest and participate on a research team. The first term of the course focuses on study design types, exploratory data analysis and summarization, sampling variability and confidence intervals, the classical bivariate comparison methods for continuous, binary and time to event data, and sample size and power consideration. The second term covers confounding, effect modification, and linear, logistic, and Cox regression models. While a statistical computing package is not required for the course, optional materials on Stata are made available to the students. Initially the enrollees were almost exclusively students in the School's Master of Public Health (MPH) degree program. Over time, the diversity of students has increased to include Master's students from the departments of Mental Health, Environmental Health, Health Policy and Management and others.

Since the year 2000, this course sequence has been taught concurrently on-campus and online. Online enrollment has increased substantially since from 35 in 2000, to a maximum of 220 (in 2010). On-campus enrollment has generally increased in the same time period, and 115 students were enrolled in 2013. While only the online version was initially developed and taught by the author, in 2003 the author also began teaching the on campus version. Since this time the instructor, teaching materials and evaluation tools have been identical between the online and on-campus versions. Despite these equivalences, the operational aspects of delivering the course differ on several factors.

The on-campus version employs a traditional combination of twice-weekly 90 minute lectures in a single on-campus lecture hall. Students are provided with a packet of course lecture materials at the beginning of each term, which are also available online. While the instructor uses this pre-arranged set of PowerPoint slides in each lecture, students are encouraged to participate by making comments and asking questions. Further, the instructor has the option of deviating from the pre-prepared materials at his discretion. All on-campus live lectures are digitally recorded and processed into MP3 files which were made available to students via a course website. Several (5) weekly office hour sessions are facilitated by course teaching assistants.

Online students are able to view pre-recorded narrated slide versions of the same lecture slides used in the on-campus live lectures. Lectures are broken into subsections, generally 20-25 minutes in length. Students may view these lectures according to their own schedules, in portions or as a whole, and have the option of reviewing lecture portions multiple times. The majority of the narrated lecture sets include a set of open ended review exercises with narrated solutions, as well as

a set of multiple choice review exercises. All narrated lecture slides, review questions and solutions are also made available to the on-campus students. Asynchronous communication between the students and the instructor is facilitated by both email and a course bulletin board (BBS). Real-time communication between the students and the instructor occurs weekly, via a one hour “live talk” session conducted over the internet. Ostensibly, these sessions serve as real-time office hours for online students, and were conducted dynamically. However, attendance at these “lives talk” sessions is optional, and all sessions are archived. While the instructor can speak to the students, students can only communicate live via typing and log of their inputs is displayed for all participants to view during the session. Additionally, the instructor can utilize a whiteboard application, which simulates a black-board in a classroom setting.

COURSE MAKEOVER 2013

The Need

While the course has been redone several times since its genesis, these were generally performed over the course of several years, and as such the materials suffered in terms of continuity and consistency. Additionally, the data sets used in the course were limited, and the journal articles outdated. Another issue was the use of Stata in the primary course note slides. Initial versions of the course were required to have a Stata component, ostensibly to give students a brief introduction to the software. However, some of the Stata code was outdated, and it also proved to be ancillary to the understanding of overarching statistical concepts in methods. Finally, the instructor had a new vision about the organization of the course, and wanted to introduce additional topics beyond the confines of this existing version. As the course was to make its Coursera debut in 2014, it was decided that this (2013) was an optimal time to initiate the makeover.

Because the course is taught online (and because of the Coursera version), all materials had to be recorded prior to their online debut. Johns Hopkins has excellent support for online teaching endeavors, including an audio recording studio and access to audio engineers. For previous versions of the course, all audio was recording in the presence of an engineer, and then edited, synced to the corresponding slides, and produced as a video object by distance education personnel. Such support is a luxury not likely provided by many institutions. However, this process was slow, and forced the instructor to cede control of the production timeline to others after the audio was recorded. Additionally there was no way to annotate the slides with written text, which necessitated the very time consuming development of multiple graphic objects and equations in the body of the slides. This lack of annotation also made the presentations less dynamic. Finally, these previous lecture versions solely consisted of stated narrated slides with no annotation – there were no video cutaways to the instructor to break up the presentation.

Curriculum Goals

The overarching curriculum related goals of this makeover included:

- An increased emphasis on summary statistics and their interpretations, with all being debuted before any material on inference
- A conceptual unification of the methods for creating confidence intervals and doing hypothesis testing. While the course would cover all of the “classics” (t-tests, chi-square, log rank etc..), the emphasis would be on the commonalities of the approaches over the specific mechanics of each.
- A conceptual unification of the linear, logistic and Cox regression.
- Obtaining interesting data sets to serve as examples throughout the two course sequences.
- Illustrating each important course topic with relatively current journal articles, spanning the diversity of interests of course enrollees.
- Creating review materials for each didactic lecture set.
- Constant reinforcement and evaluation: for each eight week term, students would be evaluated on four homework exercises and four quizzes.

- Introducing material beyond the scope of basic biostatistics into the syllabus, including propensity scores and propensity score matching, linear splines, and prediction models.

Didactic Materials Creation

Prior to making any course materials, a comprehensive set of datasets was organized, and a selection of seminal and contemporary articles from the literature was assembled. Online resources were utilized in obtaining raw data sets, including Kaggle, NHANES, NHAMCS, Hosmer and Lemeshow, and Baltimore Citistat. Journal articles include selections from the *American Journal of Public Health*, *Journal of the American Medical Association*, *Pediatrics*, *Journal of Substance Treatment*, *Environmental Health Perspectives*, *Health Affairs* and *American Journal of Psychiatry*.

Initially, Explain Everything, an Ipad application, was used to record course materials. The application is inexpensive (\$4.99!), and allows for easy annotation of .pdf slides. However, there were several drawbacks including its restriction to 4:3 slides (as opposed to 16:9 which is preferable for internet viewings), a propensity to crash with longer recordings, and the need for additional software to edit the recordings and render them as mp4s. Camtasia for Windows was next employed as the video lecture maker. While substantially more expensive than Explain Everything, this software is still reasonably priced (\$99 USD for a one year license), and does not require an Ipad. Narrated slide videos can be recorded, annotated, edited and rendered as mp4 files with Camtasia. Additionally, Camtasia can be used to make software demonstration videos. With each video lecture set, the instructor recorded a series of short videos of the instructor speaking, to be inserted into the narrated lecture slide sets. For the first term lectures, these were recorded in a video studio on the Hopkins campus, and inserted by a staff video production expert. However, because of increasing demands on the video studio and staff, this approach was not sustainable. For the second term, the instructor purchased a web camera (Logitech), and recorded these video inserts in his office. These inserts can be directly edited into the narrated lecture sets using Camtasia or Windows Moviemaker.

The Results

The Statistical Reasoning I makeover resulted in 13 lecture sets, 4 homeworks, 4 quizzes, review exercises for 10 of the 13 lecture sets, and accompanying Stata movies for lectures 2 through 10. The Statistical Reasoning II makeover resulted in 11 lecture sets, 3 homeworks (because of scheduling issues, the goal of 4 homeworks was untenable), 4 quizzes, and review exercises for all lecture sets.

From the instructor's perspective, this makeover was a resounding success. The materials were unified across two terms, and the multiple feedback opportunities for the students created a better "culture of learning and understanding". (This a qualitative assessment based on the timbre of instructor contact with the students, feedback from teaching assistants, and the activity on the online course bulletin board, and during the course live talks). Students performed well on the class quizzes, and because there were four each term, this allowed for a relatively quick identification of any difficulties with the material.

Students on the whole seemed to appreciate the course, from both a qualitative perspective, and measurable quantitative feedback. The following table shows some results from the student course evaluations 2013.

	2013	
	Term 1	Term 2
Online	(n= 128)	(n= 130)
Response Rate	93%	92%
Course Excellent	70%	66%
Instructor Excellent	83%	82%
On Campus	(n=121)	(n= 102)
Response Rate	97%	94%
Course Excellent	74%	76%
Instructor Excellent	93%	88%

Clearly, the reviews are better for the on-campus section than the online section, but even in the latter more than two-thirds rated the course as excellent. 2013 is the first year in which Johns Hopkins linked the completion of course evaluations to students' ability to access course grades. As such the completion rates are all excellent for both sections in both terms. Unfortunately, in previous years the completion rates were on the order of 60-70%, so these results are not wholly comparable with the prior year evaluations, which as such are not shown in this paper. As such, a temporal comparison of responses cannot be used to investigate the impact of the makeover on student satisfaction (with caveats about temporal confounding, etc.) .

COURSERA

The Coursera version of Statistical Reasoning I debuted as "Statistical Reasoning for Public Health: Estimation, Inference, & Interpretation" on January 21, 2014. At the time of this paper, the course is in its fifth week (out of eight), with a total enrollment of 21,600. Because all of the materials, including the video lectures had been completed in 2013, it was not difficult to get up and running with Coursera. Currently, there is one teaching assistant for the course who is responsible, along with the instructor, for monitoring the discussion board for the class.

CONCLUSION

Qualitatively and (preliminarily) quantitatively, this most recent approach to teaching Statistical Reasoning to graduated public health students is successful. Forthcoming data from the Coursera version of Statistical Reasoning 1 will yield information about the potential for the course to reach other audiences.

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